CLAIMS:

1. An X-ray diffraction method for the analysis of polycrystalline materials, the method comprising:

(a) providing a polycrystalline material for analysis;

(b) providing a polychromatic X-ray source, wherein the source produces X-rays by accelerating charged particles to energies of no more than 1 MeV;

(c) collimating X-rays from the polychromatic X-ray source into a beam having a divergence in the range of from 10^{-4} to 10^{-2} radians;

(d) exposing at least a portion of the polycrystalline material to the collimated X-ray beam, whereby the beam is diffracted;

(e) collecting at least some of the diffracted X-rays in an energy dispersive X-ray detector or array; and

(f) analysing the collected, diffracted X-rays.

2. A method as claimed in claim 1, wherein the source produces X-rays by accelerating charged particles to energies of no more than 500 keV.

3. A method as claimed in claim 1 or claim 2, wherein the energy dispersive X-ray detector has a relative energy resolution of from 0.5×10^{-2} to 5×10^{-2}.

4. A method as claimed in any one of the preceding claims, wherein the energy of the collimated X-ray beam is $\geq$ 60 keV, preferably in the range of from 100 to 300 keV.

5. A method as claimed in any one of the preceding

claims, wherein the collimated X-ray beam penetrates the polycrystalline material to an attenuation depth of ≥ 1 mm.

6. A method as claimed in any one of the preceding claims, further comprising moving the collimated X-ray beam relative to the polycrystalline material.

7. A method as claimed in claim 6, comprising scanning the collimated X-ray beam across at least a portion of the polycrystalline material, while keeping the polycrystalline material stationary.

8. A method as claimed in any one of the preceding claims, wherein the collected, diffracted X-rays are analysed in order to determine a structural and/or chemical characteristic of the polycrystalline material.

9. A method as claimed in claim 8, wherein the structural characteristic is the lattice parameter.

10. A method as claimed in claim 9, wherein lattice parameter determination is used to provide information on phase distributions, stresses and/or strains in the polycrystalline material.

11. A method as claimed in claim 10, wherein lattice parameter determination is used to map phase distributions, stresses and/or strains in the polycrystalline material.

12. A method as claimed in claim 11, wherein lattice parameter determination is used to map phase distributions, stresses and/or strains in the polycrystalline material at a depth of ≥ 1 mm.

13. A method as claimed in any one of the preceding claims, wherein the polycrystalline material is an engineering article or component part thereof.

14. A method as claimed in any one of the preceding claims, wherein the polycrystalline material comprises a metal or alloy, ceramic or crystalline polymer, including combinations of two or more thereof.

15. A method as claimed in any one of the preceding claims, wherein the polycrystalline material is a composite material comprising a crystalline phase.

16. A method as claimed in claim 15, wherein the metal matrix composite material is a glass and/or ceramic reinforced metal matrix composite material.

17. A method as claimed in any one of the preceding claims, wherein said portion of the polycrystalline material has a thickness of $\geq$ 1 mm.

18. An apparatus for X-ray diffraction analysis of polycrystalline materials, the apparatus comprising:

(i) a polychromatic X-ray source, wherein the source produces X-rays by accelerating charged particles to energies of no more than 1 MeV;

(ii) means for collimating X-rays from the polychromatic X-ray source into a beam having a divergence in the range of from 10^{-4} to 10^{-2} radians;

(iii) an energy dispersive X-ray detector or array for collecting at least some of the diffracted X-rays resulting, in use, from exposing at least a portion of a polycrystalline material to the collimated X-ray beam; and

(iv) means for analysing the collected, diffracted

X-rays.

19. An apparatus as claimed in claim 18, wherein the polychromatic source is moveable with respect to a polycrystalline material to be analysed.

20. An apparatus as claimed in claim 18 or claim 19, wherein the collimated X-ray beam is adapted, in use, to scan, across the polycrystalline material, while the polycrystalline material is maintained stationary.

21. A method of quantitatively mapping the sub-surface distribution of the crystal lattice parameter in a polycrystalline material, the method comprising:

(a) providing a sample for analysis, wherein the sample comprises a polycrystalline material;

(b) providing a polychromatic X-ray source, wherein the source produces X-rays by accelerating charged particles to energies of no more than 1 MeV;

(c) collimating X-rays from the polychromatic X-ray source into a beam having a divergence in the range of from 10^{-4} to 10^{-2} radians, and a penetration depth of $\geq$ 1 mm;

(d) scanning the collimated X-ray beam across the sample, whereby the beam is diffracted;

(e) collecting at least some of the diffracted X-rays in an energy dispersive X-ray detector or array; and

(f) analysing the collected, diffracted X-rays to map the lattice parameter in the polycrystalline material.

22. A method as claimed in claim 21, wherein the polycrystalline material is a natural material or an engineering material, including a component formed

therefrom.

23. A method as claimed in claim 21 or claim 22, further including:

(f) transforming the map of the lattice parameter into a map of sub-surface engineering stresses and/or strains.